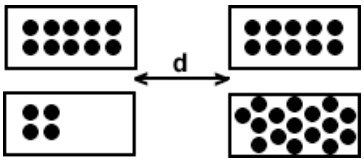
Physics 180B
Final Test - 120 Points

Name _____

*You need to do answer **10 of 12** problems below. **Cross-out** the **2** you do want graded. No extra credit.*

1. Two microscopic bags each contain 10 protons. When they are separated by a distance d, the electrical force on each bag due to the other bag is F. You now transfer 6 protons from one bag to another without changing anything else. The electrical force on each bag is now. (6 points)

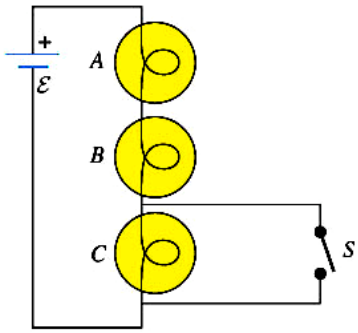


a. 5/3 F
b, 3/5 F
c. 25/16 F
d. 16/25 F

2. Three identical light bulbs, *A*, *B*, and *C*, are connected in the circuit shown in the figure. When the switch *S* is closed,

(3 points)

a. the brightness of *A* and *B* increases, but *C* goes out.
b. the brightness of *A* and *B* remains the same as it was, but *C* will be about half as bright as it was.
c. the brightness of *A* and *B* decreases, and *C* goes out.
d. the brightness of *A* and *B* increases, and *C* will be about half as bright as it was.
e. the brightness of *A* and *B* remains the same as it was, but *C* goes out.



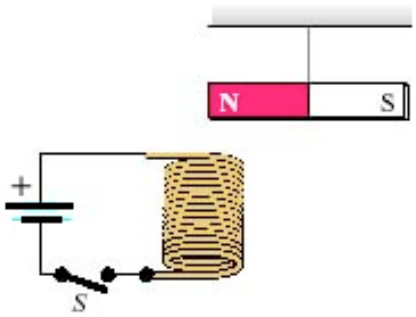
(3 points)

a. C will dim because less current will flow through it.
b. C will act as on open circuit.
c. C goes out because the switch is a short circuit

3. A coil is connected to a battery as shown in the figure. A bar magnet is suspended with its N pole just above the center of the coil. What will happen to the bar magnet just after the switch S is closed?

(3 points)

a. It will be pulled toward the coil.
b. It will be pushed away from the coil.
c. It will be pushed out of the paper.
d. It will be pushed into the paper.

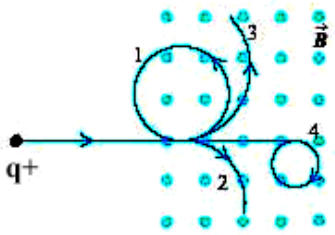


(3 points)

a. because there is no magnetic field due to a constant current.
b. because the magnetic field of the coil is attractive.
c. Because the magnetic field of the coil is repulsive.

4. A positively charged particle shoots into a uniform magnetic field directed out of the paper. A possible path of this particle is (3 points)

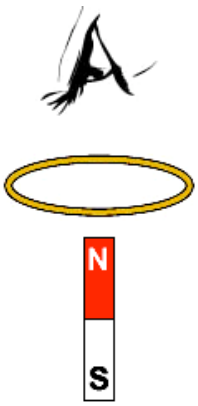
a. 4 b. 3 c. 2 d. 1



A particle cannot follow path 3 because (3 points)

a. the force is pointed outward outside the mag field.
b. there is no force on the particle outside the mag field.
c. the force is tangential to the path outside the field.

5. A metal loop is held above the S pole of a bar magnet, as shown in the figure, when the magnet is suddenly dropped from rest. Just after the magnet is dropped, the induced current in the loop, as viewed from above it, is directed (6 points)



a. According to **Ampere's Law**, the induced magnetic field in the loop will want to repel the magnet out of the loop because there is an increasing magnetic flux through the loop. So, the current will go in a CW direction, as viewed from above.

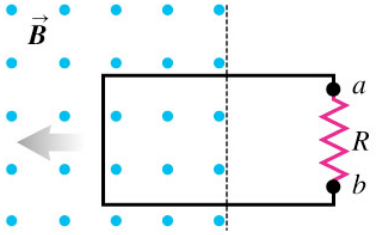
b. According to **Ampere's Law**, the induced magnetic field in the loop will want to attract the magnet back into the loop because there is a decreasing magnetic flux through the loop. So, the current will go in a CCW direction, as viewed from above.

c. According to **Lenz's Law**, the induced magnetic field in the loop will want to attract the magnet back into the loop because there is a decreasing magnetic flux through the loop. So, the current will go in a CCW direction, as viewed from above.

d. According to **Lenz's Law**, the induced magnetic field in the loop will want to repel the magnet out of the loop because there is an increasing magnetic flux through the loop. So, the current will go in a CW direction, as viewed from above.

c. Zero current.

6. A metal loop is being pushed at a constant velocity into a uniform magnetic field, as shown in the figure, but is only partway into the field. As a result of this motion, (6 points)

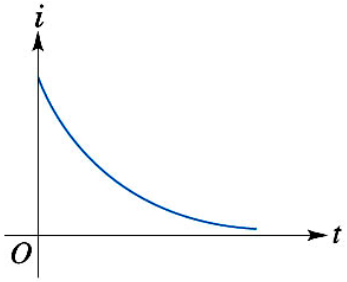


a. There is no potential across R due to no changing flux.
b. Ends *a* and *b* are at the same potential.
c. End *b* of the resistor R is at a higher potential than end *a.*
d. End *a* of the resistor R is at a higher potential than end *b.*

7. The graph in the figure shows the current in a resistor-capacitor circuit as a function of time. From this graph, we can tell that (3 points)

a. the capacitor must be charging.
b. the capacitor must be discharging.
c. the capacitor could be either charging or discharging, but we cannot tell which it is.

(3 points)



Which statement(s) are correct about the circuit?

a. The capacitor is completely uncharged at t = infinity
b. The current thru the circuit is a maximum at t = 0.
c. The current thru the circuit is a minimum at t = 0.
d. The capacitor is completely charged at t = infinity

8. Light travels from water (with index of refraction 1.33) into air (index of refraction 1.00). Which of the following statements about this light is true? (There may be more than one correct choice.) (6 points)

a. The light has the same wavelength in the air as it does in the water.
b. The light has the same frequency in the air as it does in the water.
c. The light travels faster in the air than in the water.
d. The wavelength of the light in the air is greater than the wavelength in the water.
e. The light has the same speed in the air as in the water.

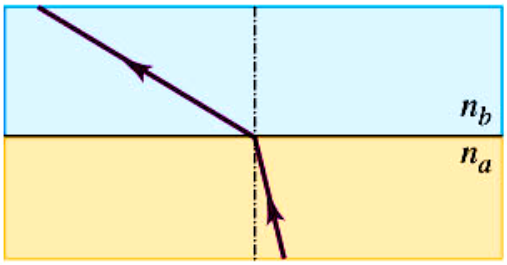
9. A ray of light going from one material into another follows the path shown in the figure. What can you conclude about the relative indexes of refraction of these two materials? (6 points)

a. $n_a < n_b$

b. $n_a > n_b$

c. $n_a \geq n_b$

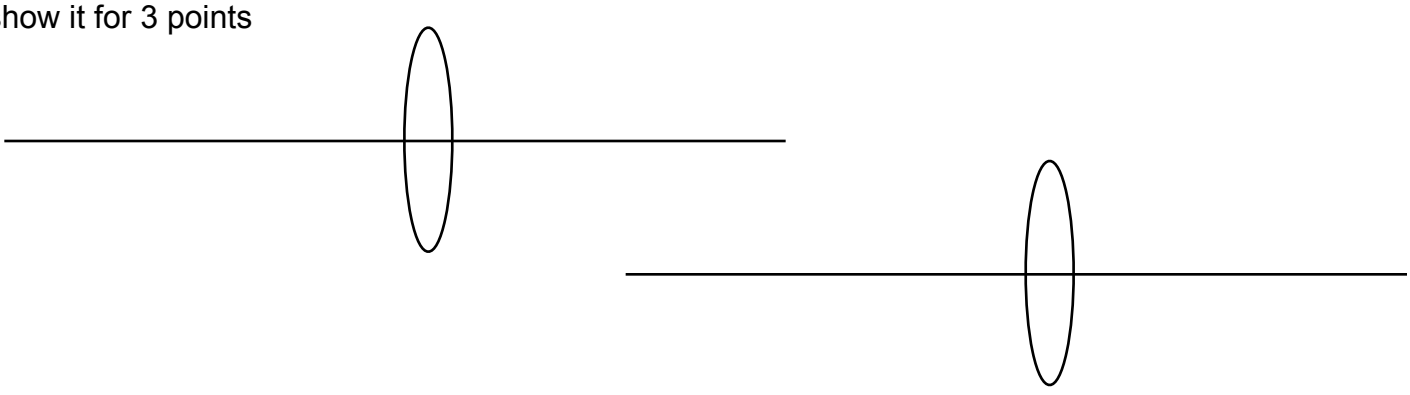
d. $n_a \leq n_b$



10. An object lies outside the focal point of a converging lens. Which of the following statements about the image formed by this lens must be true? (3 points)

a. The image is always real and inverted.
b. The image is always on the opposite side of the lens from the object.
c. The image could be real or virtual, depending on how far the object is past the focal point.
d. The image could be erect or inverted, depending on how far the object is past the focal point.

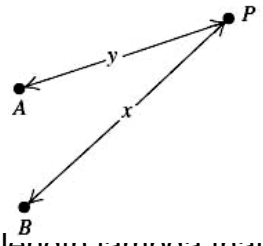
show it for 3 points



11. At point P, the path difference for waves from these two sources is (3 points)

a. $\frac{x+y}{2}$ b. $x+y$

c. $\frac{x-y}{2}$ d. $x-y$



if the sources A and B in the figure are emitting waves of wavelength lambda that are in phase with each other, *constructive* interference will occur at point P if (there may be more than one correct choice): (3 points)

a. $x-y=2\lambda$ b. $x+y=\lambda$

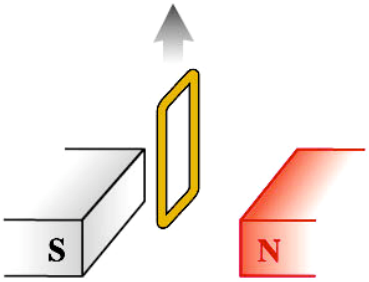
c. $x=y$ d. $x-y=5\lambda$

12. A square loop of wire is pulled upward out of the space between the poles of a magnet, as shown in the figure. As this is done, the current induced in this loop,
as viewed from the N pole of the magnet, will be directed

(3 points)

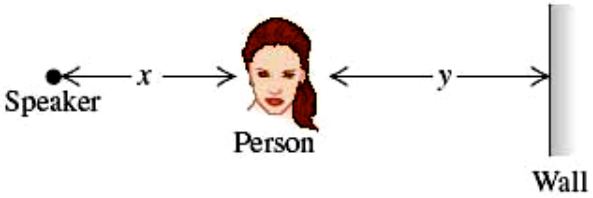
a. clockwise.
b. counterclockwise.
c. zero.

(prove it on the diagram for 3 points)



13. A person is standing at a distance x from a stereo speaker that is emitting a continuous tone. She hears the sound directly from the speaker, as well as the sound reflected from a wall a distance $y\,(x>y)$ away. The path difference between these two sound waves as they reach the listener is

Show it for (3 points)



(answer it for 3 points)

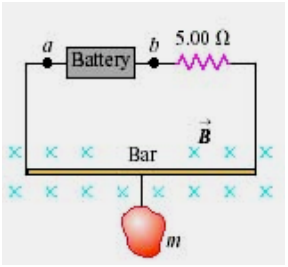
a. $y-x$ b. $2y-x$ c. $x+y$ d. $2y$ e. $2x$

Answer only 5 problems below. Cross out 2 problems. No extra credit, please.

1. Two large metal parallel plates carry opposite charges of equal magnitude. They are separated by 45.0 mm, and the potential difference between them is 340 V. What is the magnitude of the electric field (assumed to be uniform) in the region between the plates? What is the magnitude of the force this field exerts on a particle with charge 2.60 nC? (12 points you need to show work)

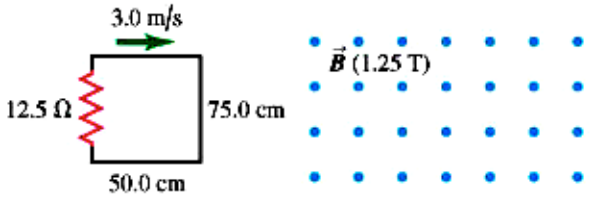
2. Two small spheres spaced 15.0 cm apart have equal charge. How many excess electrons must be present on each sphere if the magnitude of the force of repulsion between them is 6.25×10^{-21} N? (12 points you need to show work)

3. The circuit shown in the figure is used to make a magnetic balance to weigh objects. The mass m to be measured is hung from the center of the bar, which is in a uniform magnetic field of 3.57 T directed into the plane of the figure. The battery voltage can be adjusted to vary the current in the circuit. The horizontal bar is 65.0 cm long and is made of extremely lightweight material, so its mass can be neglected. It is connected to the battery by thin vertical wires that can support no appreciable tension; all the weight of the mass m is supported by the magnetic force on the bar. A 5.00 ohms resistor is in series with the bar, and the resistance of the rest of the circuit is negligibly small. Which point, a or b, should be the positive terminal of the battery? If the maximum terminal voltage of the battery is 210 V, what is the greatest mass m that this instrument can measure? (12 points you need to show work)



4. An 2200 W toaster, a 1000 W electric frying pan, and a 150 W lamp are plugged into the same electrical outlet in a 25.0 A, 120 V circuit. (*Note:* When plugged into the same outlet, the three devices are in parallel with each other across the 120 V outlet.) What current is drawn by the toaster? What current is drawn by the electric frying pan? What current is drawn by the lamp? Will this combination blow the circuit breaker? (12 points you need to show work)(12 points you need to show work)

5. A rectangular circuit is moved at a constant velocity of 4.50 m/s into, through, and then out of a uniform 2.25 T magnetic field, **but instead the field is OUT of the page**. The magnetic field region is considerably wider than 45.0 cm. Find the direction (clockwise or counterclockwise) of the current induced in the circuit as it is going into the magnetic field (the first case), totally within the magnetic field but still moving (the second case), and moving out of the field (the third case). Show it on the diagram. Find the magnitude of the current induced in the circuit as it is going into the magnetic field . Find the magnitude of the current induced in the circuit as it is totally within the magnetic field but still moving . Find the magnitude of the current induced in the circuit as it is moving out of the field . (12 points you need to show work)



6. The critical angle for total internal reflection at a liquid-air interface is 38.5°. If a ray of light traveling in the liquid has an angle of incidence of 35.0° at the interface with respect to the normal, what angle does the refracted ray in the air make with the normal? If a ray of light traveling in air has an angle of incidence of 35.0° at the interface with respect to the normal, what angle does the refracted ray in the liquid make with the normal? (12 points you need to show work)

7. When two lenses are used in combination, the first one forms an image that then serves as the object for the second lens. The magnification of the combination is the ratio of the height of the final image to the height of the object. A 1.20 cm-tall object is 50.0 cm to the left of a lens of focal length of magnitude 40.0 cm. A second lens, this one having a focal length of magnitude 60.0 cm, is located 300 cm to the right of the first lens along the same optic axis. Find the location and height of the image (call it I_1) formed by the lens with a focal length of 40.0 cm if the first lens is *converging* and the second lens is a *diverging*. I_1 is now the object for the second lens. Find the location and height of the image produced by the second lens. (12 points you need to show work)

8. Two identical audio speakers connected to the same amplifier produce in-phase sound waves with a single frequency that can be varied between 340 and 650 Hz. The speed of sound is 340 m/s. You find that where you are standing, you hear minimum-intensity sound. Explain why you hear minimum-intensity sound. If one of the speakers is moved 38.8 cm toward you, the sound you hear has maximum intensity. What is the frequency of the sound? How much closer to you from the position in part B must the speaker be moved to the next position where you hear maximum intensity? (12 points you need to show work)